DISCUSSION AND CORRESPONDENCE

CLIMATIC CHANGES

DR. HUMPHREYS' review of "Climatic changes, their nature and causes," by Dr. Ellsworth Huntington and Dr. Stephen Sargent Visher (Yale University Press, 1922), in SCIENCE, Vol. LVII., pp. 389–391, March 30, 1923, conveys, I feel sure, an erroneous impression, for it fails to treat commendable features and to give any idea of the contents of the book.

"Climatic Changes" is a very comprehensive treatment of the wide subject of climatic changes in the history of the earth. The work begins with chapters on the remarkable uniformity of the climate in geologic time and on the variability of the climate. The following types of climatic sequences are distinguished: (1) Cosmic uniformity; (2) secular progression; (3) geologic oscillations; (4) glacial fluctuations; (5) orbital precessions; (6) historical pulsations; (7) Brückner periods; (8) sunspot cycles; (9) seasonal alternations; (10) pleionian migrations; (11) cyclonic vacillations; (12) daily vibrations.

A review and discussion of the principal hypotheses of the causes of climatic changes brings the treatment up to Huntington's own hypothesis, the solar cyclonic. This hypothesis is shortly as follows: Newcomb and Köppen have shown that the temperature of the earth's surface varies in harmony with variations in the number and area of the sunspots. Furthermore, Abbot has found that the amount of heat radiated from the sun also varies, and that in general the variations correspond with those of the sunspots. Sunspot maximum corresponds to the lowest temperature at the surface of the earth. Finally, it has been found that atmospheric pressure also varies in harmony with the number of sunspots. The variations are different in different parts of the earth, but systematic, and the net result is that, when sunspots are numerous, the earth's storminess increases. This interferes with the trade winds of low latitudes and the prevailing westerlies of higher latitudes, causing frequent hurricanes in the tropics and more frequent and severe cyclones in the temperate regions. With the change in storminess there naturally goes a change in rainfall. Thus, when the atmosphere of the sun is particularly disturbed, the meteorological differences between different parts of the earth's surface are strengthened.

The low temperature during times of many sunspots may be due largely to convection and to increased velocity of the winds by which the surface of the earth is actually cooled off a little. The cause of the storminess, when the sun's atmosphere is disturbed, is not quite clear, but, beside the heating of the earth's surface by the sun, electric phenomena of some kind appear to play a rôle.

Investigations have shown that sunspot cycles on a small scale present almost the same phenomena as do historic or glacial fluctuations. "When sunspots are numerous, storminess increases markedly in a belt near the northern border of the area of greatest storminess, that is, in southern Canada and thence across the Atlantic to the North Sea and Scandinavia. Corresponding with this is the fact that the evidence as to climatic pulsations in historic times indicates that regions along this path, for instance Greenland, the North Sea region, and southern Scandinavia, were visited by especially frequent and severe storms at the climax of each pulsation. Moreover, the greatest accumulations of ice in the glacial period were on the poleward border of the general regions where now the storms appear to increase most at times of solar activity."[1] "From these and many other lines of evidence it seems probable that historic pulsations and glacial fluctuations are nothing more than sunspot cycles on a large scale."[2]

After these introductory and theoretical chapters the authors take up the discussion of certain climatic problems. The headings of the chapters will give an idea of the diversity of the problems dealt with: "The climate of history;" "The climatic stress of the fourteenth century;" "Glaciation according to the solar cyclonic hypothesis;" Some problems of glacial periods;" "The origin of loess;" "Causes of mild geological climates;" "Terrestrial causes of climatic changes;" "Post-glacial crustal movements and climatic changes;" "The changing composition of oceans and atmosphere;" "The effect of other bodies on the sun;" "The sun's journey through space;" "The earth's crust and the sun."

In certain respects the undersigned disagrees with the conclusions of "Climatic Changes." Thus, when percipitation is considered to be of greater importance than temperature for the Pleistocene glaciations, it may have been overestimated. The best known glacialists, practically without exception, regard temperature as the chief controlling factor. Particularly do A. Penck, E. Brückner and A. von Reinhard regard temperature, not precipitation, as the decisive factor for the glaciations in the Alps and the Caucasus.

The nourishment of the ice sheets, according to Huntington and Visher, occurred largely by snowfall from cyclonic storms.[3] They infer that heavy precipitation and the formation of great snowfields took place first in the central areas of what later became the great continental ice sheets. Hence ice began to flow out from these centers. Later, however, the extreme development of high pressure areas over the ice

[1] P. 57, 60.

[2] P. 60.

[3] Pp. 116, 125, 136.

sheets is supposed to have forced the cyclonic storms to skirt the ice rather than cross its central parts. Our knowledge on this point is very limited, but since boulders were transported by the European ice sheets from near the center of glaciation out to the terminal moraines in central Europe, the expansion of the ice sheet to a large degree must have been controlled by precipitation in its central parts. Recently Simpson[4] has given a seemingly very good explanation of the snowfall in the Antarctic anticyclone. The precipitation, according to his view, is brought about by the low temperature of the lower strata of the air. This air is raised and cooled still further during blizzards and hence gives up the small amount of moisture which it contains.

The opinion that evaporation during the glaciation was greater than normally[5] perhaps is open to doubt, but that there was a considerable transport of moisture from low to high latitudes seems to be certain.[6]

The discussion of the causes of the disappearance of the ice sheets is not quite consistent.[7] It starts with correctly setting forth rise of temperature and diminution of precipitation as the chief general causes, but ends with largely attributing the vanishing of the different sheets of land ice to more local conditions. Most studies of the disappearance of the North European and the Labradorean ice sheets seem to show that during the ice retreat the temperature was relatively high and the precipitation slight.

Again, topographic conditions *can* readily explain many climatic problems, but their actual rôle seems sometimes to have been overestimated. So, the supposed good example of close relationship between high elevation of land and continental climate, and low elevation and maritime climate in northwest Europe during late-glacial and post-glacial time, maintained by C. E. P. Brooks, is partly unfounded, as it is based upon an incorrect interpretation of the changes of level. Even the moderate view taken in "Climatic Changes," pp. 215–222, goes too far. During the transition between the late-glacial and post-glacial periods, that is in Ancylus or boreal time, there was no extensive elevation, no continental phase as far as the land is concerned; and recently Lennart von Post seems to prove that the climate instead of being continental as supposed was maritime with dry summers and winters rich in precipitation.

In the discussion of the origin of glacial loess, which is supposed to have been accumulated mainly during the retreat of the ice, the undersigned misses references to B. Shimek, A. Jentzsch, and P. Tutkowski, who have expressed similar ideas.

A very strong side of "Climatic Changes" is that it really faces the difficulties, and takes up the problems which call for discussion, even if our present imperfect knowledge does not permit a satisfactory explanation of all of them. The solar cyclonic hypothesis seems more competent than any other existing hypothesis to explain the complexity and the rapid and heterogeneous changes of the Pleistocene climate, which are now beginning to be fairly well known, especially thorough studies in Sweden. Our present knowledge of the Pleistocene climate eliminates most and perhaps all the hypotheses which seek the causes of climatic variations in terrestrial conditions only. It seems as if Huntington has found a very important, perhaps the chief, cause of climatic changes.

ERNST ANTEVS

[4] G. C. Simpson, "Meteorology," Vol. I.—British Antarctic Expedition, 1910–1913. Calcutta, 1919. Reference on pp. 256–269.

[5] Pp. 113 ,114.

[6] P. 118.

[7] P. 128.

COLOR HEARING

I HAVE been interested for a long time in color hearing, and therefore read eagerly the article by Professor Horace B. English, of Antioch College, in SCIENCE of April 13, "And a little child shall lead them." The deductions of the three-year-old were charming.

I add my personal experience. Having met a friend in town some years ago, we fell into conversation on the possibilities of color hearing, which had been characterized as absurd. Going to my home, I said to my mother, without any preliminaries, "Mother, what color is my voice?" Without hesitation and as if I had asked her the color of a ribbon or a book-cover, she replied, "Dove-color."

I expressed my surprise that she should hear color. "Why," said she, "I have always heard color. When I went to school, there was a little girl whom I disliked very much, because she had such a yellow voice." But in all her long life (she was then over eighty) color hearing had never been spoken of. I then asked her the color of the voices of various friends, which she gave with perfect readiness. She characterized the voice of Louis Prang as having the colors of the rainbow.

Some days after this conversation, I went to New York on my way to Brooklyn to speak before an educational gathering on "Color." As I walked along Broadway, I noticed in a shop window, in which Oriental rugs were displayed, a placard which said, "A noted East Indian will tell fortunes, will read the hand and will tell the color of the voice." Feeling that I might get material appropriate to the address I was to give, I went in and was shown to a tent-like booth, in which was seated a fine-looking Hindu in full Oriental costume.

He received me in a dignified manner, read my